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Cladonia dunensis sp. nov. from southern Brazil, with notes on the genus in beach dune environments

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Abstract — *Cladonia dunensis* is described. The new species resembles *C. celata* in the corticate and scyphose podetia that are simple at first before branching fastigiately but differs in forming squamulose podetia and producing psoromic acid. Seven *Cladonia* species are reported for the first time from beach dune environments in the coastal plain of Santa Catarina State, southern Brazil.

Key words — *Ascomycota*, *Cladoniaceae*, dimorphic thallus, lichens, taxonomy

Introduction

In the Brazilian coastal areas, sand dune habitats are covered by herbaceous, arbustive and arboreal vegetation types named restinga vegetation (Araujo 1992). The lichenized restinga mycota has been intensively studied in the last decade, primarily within arbustive-arboreal vegetation (e.g., Benatti & Marcelli 2008, 2009; Dal-Forno & Eliasaro 2010 a,b; Donha & Eliasaro 2006; Marcelli & Benatti 2011; Martins & Marcelli 2011). However, there is no information about species that colonize the beach dune environments in Brazil (Marcelli 1998).

Cladonia P. Browne, the largest genus in *Cladoniaceae* with c. 400 species (Stenroos et al. 2002; Burgaz & Ahti 2009), is frequent and abundant in arbustive restinga vegetation (Ahti 2000; Gumboski & Eliasaro 2012a,b), and some species can colonize other adjacent environments.

As a part of a survey of the *Cladoniaceae* in the coastal region of southern Brazil (Gumboski & Eliasaro 2012a,b) we present a first report on *Cladonia* species found in the beach dune environment in Brazil, one of which is new to science. Descriptions, comments and illustrations are presented.

Materials & methods

The specimens were collected in depressions between beach dunes in the Municipality of Imbituba, Santa Catarina State, Brazil (Fig. 1). Specimens were examined using standard stereoscopic (20–50×) and light microscopic (400–1000×) techniques. Sections of primary thallus, podetia, and pycnidia were mounted in water. Chemical constituents were identified by spot tests, under UV light, and thin layer chromatography using solvent system C (Orange et al. 2001) and by comparison with authentic samples.

Taxonomy

Cladonia dunensis Gumboski, Beilke & Eliasaro, **sp. nov.** Fig. 2

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Differs from *Cladonia celata* by its squamulose podetia and by its production of psoromic acid.

Type: Brazil. Santa Catarina State: Municipality of Imbituba, 28°17′57″S 48°42′14″W, sea level, on acid soil in depressions between dunes, 19 Feb 2010, E. Gumboski & F. Beilke 1750 (**Holotype**, UPCB; **isotypes**, ICN, JOI).

Etymology: The epithet refers to the habitat of this species.

Primary thallus evanescent, lobate squamules, 1.0–3.0 mm long, 0.5–1.2 mm wide, planes, not divided, smooth margins, without rhizines, esorediate; upper surface greenish to whitish, corticate, smooth, not pruinose, without pycnidia, lower surface white, ecorticate, smoothly arachnoid; cortex 40–70 μm, medulla 110–420 μm. Podetia 0.8–2.0 cm tall, 0.4–0.9 mm thick, greenish to brownish, scyphose, irregularly branching, at first simple then finally fastigiate mainly dichotomously, but with irregular branches common on podetial sides; scyphi sometimes deformed at margin, ≤1.2 mm wide; surface corticate and verrucose, sometimes cracked (some cracks can reveal the white medulla below), without soredia or granules, schizidia and squamules present, lobate squamules ≤0.5 mm long; cortex 20–50(–80) μm, medulla 50–120 μm, hyaline stereome, 130–190 μm, papillate central canal, 270–500 μm wide. Hymenial disks common, globose, apical on podetia, pale brown to brownish, immature, ascospores not seen. Pycnidia rare, brow to blackish, to 0.2 mm wide, slime and conidia not seen.

Chemistry: Thallus K–, C–, KC–, UV–. Psoromic acid [major] and 2'-O-demethylpsoromic acid [minor] detected by TLC.

Ecology and distribution: The new species is known only on sandy soil in depressions between dunes, where it usually grows intermixed with other *Cladonia* species, such as *C. ramulosa*, *C. didyma*, and *C. merochlorophaea*. This area, characterized by acidity and high humidity, develops an herbaceous vegetation that is often used for cattle grazing and is periodically burned, as observed in November 2011; thus the species is endangered.

Additional specimens examined: **BRAZIL. Santa Catarina State**: Municipality of Imbituba, 28°17′57″S 48°42′14″W, sea level, 19 Feb 2010, E. Gumboski & F. Beilke 1754b (JOI).

Figure 1. The studied area: dunes from Municipality of Imbituba, Santa Catarina State, Brazil.

Figure 2. *Cladonia dunensis* (holotype). Scale bar = 1 cm.

Remarks: The new species is characterized by the evanescent primary squamules, short, corticate, scyphose and squamulose podetia, at first simple then branching fastigiately, by the brownish ascomata, and the psoromic acid production.

According to the infrageneric classification suggested by Stenroos et al. (2002), *Cladonia dunensis* probably belongs in supergroup *Cladonia* based on its squamulose primary thallus, sparsely branched corticate podetia, unperforated axils, and brownish ascomata.

Cladonia dunensis resembles *C. celata* A.W. Archer in similar podetia (Archer 1984, 1992). However, *C. dunensis* has squamulose podetia with schizidia and contains psoromic acid, while *C. celata* has podetia without schizidia and squamules and produces fumarprotocetraric acid. These two species also exhibit disjunct geographic distributions, with *C. celata* occurring at 450–1100 m in Australia (Archer 1984), whereas *C. dunensis* is known only from the type locality at sea level in dune environments in southern Brazil.

Cladonia fruticulosa Kremp. differs morphologically in having a persistent primary thallus up to 5(–10) mm long and 2(–3) mm wide with crenate-incised to deeply divided squamules, moderately branching podetia with variably smooth or roughly corticate to partly or almost totally sorediate surfaces, and is found at 440–3800 m (Swinscow & Krog 1988; Stenroos 1988).

The specimens of *Cladonia ochracea* found in the studied area are quite similar to *C. dunensis*, but *C. ochracea* has scyphose to capitate podetia, produces fumarprotocetraric acid and grows up to 3.5 cm tall.

Psoromic acid is very rare in *Cladonia* species from Brazil. Gumboski & Eliasaro (2012a,b) recorded 23 species from restinga vegetation and rocky shores from southern Brazil, and none of them produced this compound. Ahti (2000) recorded 180 species from Brazil and psoromic acid was detected in only some specimens of *C. acuminata* (Ach.) Norrl., *C. cartilaginea* Müll. Arg., and *C. dactylota* Tuck. Both *C. acuminata* and *C. cartilaginea* have ascyphose podetia that have a granulose-sorediate surface in *C. acuminata* (Ahti 2000) and are decorticate in *C. cartilaginea* (Herb. ICN, M. Fleig 3416, 6041). In *Cladonia dactylota* the primary thallus is persistent, sometimes sorediate, and the podetia, although scyphose, have sorediate surface with tuberculose soralia below the scyphi or on podetial stalks (Ahti 2000; Herb. ICN, M. Fleig 5191, 5969).

The six other species found in beach dune environments are:

Cladonia crispatula (Nyl.) Ahti, Lichenologist 9: 14. 1977.

Ecological notes: Specimens were found mainly between herbs and isolated from other species on sandy soil. The specimens are smaller and

less frequent when compared to those seen in arbustive restinga vegetation (Gumboski & Eliasaro 2012b).

Specimens examined: **BRAZIL. Santa Catarina State**: Municipality of Imbituba, 28°17′S 48°42′W, sea level, 19 Feb 2010, E. Gumboski & F. Beilke 1754a, 1755 (JOI); 10 Nov 2011, E. Gumboski, F. Beilke & S. Eliasaro 3020, 3027 (JOI).

Distribution: Occurs from sea level to 2000 m. Recorded only from South America: Brazil, Paraguay and Uruguay (Ahti 2000).

See Ahti (2000), Gumboski & Eliasaro (2012b) for descriptions.

Cladonia didyma (Fée) Vain., Acta Soc. Fauna Fl. Fenn. 4: 137. 1887.

Ecological notes: The most frequent species found in the beach dunes, growing on sandy soil in open sites or between herbs. Usually intermixed with *C. ochracea* and *C. ramulosa* specimens.

Specimens examined: **BRAZIL. Santa Catarina State**: Municipality of Imbituba, 28°17′S 48°42′W, sea level, 19 Feb 2010, E. Gumboski & F. Beilke 1751 (JOI); 10 Nov 2011, E. Gumboski, F. Beilke & S. Eliasaro 3017, 3022 (JOI).

Distribution: Cosmopolitan, from sea level to 3000 m (Ahti 2000). Recorded from Oceania, Asia (Vainio 1887), Africa (Doidge 1950), North America (Fulford 1937), Central America (Vainio 1887), and South America in Argentina (Calvelo & Liberatore 2002), Bolivia (Ahti 2000), Brazil (Krempelhuber 1876, as *C. muscigena*), Chile (Crombie 1876, as *C. melanodes*), Colombia, Ecuador (Ahti 2000), Guyana (Sipman 1990), and Paraguay, Peru, Suriname, Trinidad & Tobago, Uruguay, Venezuela (Ahti 2000).

See Ahti (2000), Ahti & Hammer (2002), Gumboski & Eliasaro (2012b) for descriptions.

Cladonia latiloba Ahti & Marcelli, Fl. Neotrop., Monogr. 78: 249. 2000.

Ecological notes: Only little thalli of this species were found. The specimens were growing on sandy soil in open sites without vegetation cover around them and usually isolated from other species of *Cladonia*.

Specimens examined: **BRAZIL. Santa Catarina State**: Municipality of Imbituba 28°17′S 48°42′W, sea level, 19 Feb 2010, E. Gumboski & F. Beilke 1756, 1755 (JOI); 10 Nov 2011, E. Gumboski, F. Beilke & S. Eliasaro 3018, 3019, 3026 (JOI).

Distribution: Recorded only from Brazil, at sea level (Fleig et al. 1995; Ahti 2000).

See Ahti (2000), Gumboski & Eliasaro (2012a) for descriptions.

Cladonia merochlorophaea Asahina, J. Jap. Bot. 16: 713. 1940.

Ecological notes: The specimens were represented by scattered podetia, almost always intermixed with *C. ochracea* and *C. ramulosa* specimens on sandy soil in open places.

Specimens examined: **BRAZIL. Santa Catarina State**: Municipality of Imbituba, 28°17′S 48°42′W, sea level, 19 Feb 2010, E. Gumboski & F. Beilke 1749 (JOI); 10 Nov 2011, E. Gumboski, F. Beilke & S. Eliasaro 3021, 3025 (JOI).

Distribution: According to Ahti (2000), this species usually occurs in high altitudes from 900 to 4100 m. Recorded from Oceania (Galloway 1985), Asia (Ahti 1976), Europe (Asahina 1940), North America (Archer 1992), and South America in Brazil (Fleig et al. 1995), Colombia (Flakus et al. 2008), Peru, and Venezuela (Ahti 2000).

See Ahti (2000), Burgaz & Ahti (2009), Gumboski & Eliasaro (2012a) for descriptions.

Cladonia ochracea L. Scriba, Cladon. Exs.: no. 1006. 1923.

Ecological notes: Usually growing intermixed with *C. didyma* and *C. ramulosa* specimens on sandy soil in open places. A few specimens were found growing on decaying logs and on an anthill between herbs.

Specimens examined: **BRAZIL. Santa Catarina State**: Municipality of Imbituba, 28°17′S 48°42′W, sea level, 19 Feb 2010, E. Gumboski & F. Beilke 1752 (JOI); 10 Nov 2011, E. Gumboski, F. Beilke & S. Eliasaro 3023, 3028 (JOI).

Distribution: Occurs from sea level to 1900 m (Ahti 2000). Recorded only from South America in Argentina (Ahti 2000), Brazil (Osorio & Fleig 1991), and Paraguay and Uruguay (Ahti 2000).

See Fleig et al. (1995), Ahti (2000), Gumboski & Eliasaro (2012a) for descriptions.

Cladonia ramulosa (With.) J.R. Laundon, Lichenologist 16: 225. 1984.

Ecological notes: The specimens were mainly found as scattered podetia usually growing intermixed with *C. didyma* and *C. ochracea* specimens on sandy soil in open places.

Specimens examined: **BRAZIL. Santa Catarina State**: Municipality of Imbituba, 28°17′S 48°42′W, sea level, 19 Feb 2010, E. Gumboski & F. Beilke 1748, 1753 (JOI); 10 Nov 2011, E. Gumboski, F. Beilke & S. Eliasaro 3024 (JOI).

Distribution: Cosmopolitan (Burgaz & Ahti 2009), occurring from sea level to 2000 m (Ahti 2000). Recorded from Oceania, Asia, Europe, Africa, North America, Central America (Vainio 1894, as *C. pityrea*), and South America in Argentina (Ferraro & Ahti 1987), Brazil (Osorio & Fleig 1988), Colombia, Paraguay (Ahti 2000), Peru (Vainio 1894, as *C. pityrea*), and Uruguay and Venezuela (Ahti 2000).

See Ahti (2000), Burgaz & Ahti (2009), Gumboski & Eliasaro (2012a) for descriptions.

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